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Some Observations, Directions and Inquiries Concerning the Motion of Sap in Trees, in pursuance of what was formerly begun therein, about the latter end of 1668. and the next following Spring, by Dr Ezerel Tonge, and Francis Willoughby Esq;

We shall here begin, according to the order of time, with the late Communications of D. Tonge, which are as follows;

I Now begin my Inquiries and remarks upon the last published Observations of those Ingenious persons Mr Willoughby and Mr Wray in your *Ph. Transact.* N. 48. June 21. 1669. And First, to the 3d and 4th Experiments I propose this Inquiry; At what Season of the year, Month, day, and in what wind and weather, Branches and young Trees (especially small Branches) are so full of Sap, that, being held perpendicular, they will bleed at both ends, as is there related; and Roots, both ways? And what gage the Barometers and Thermometers then held? And in what forwardness their Buds and Leaves, or Chats were then shot, or broken? And of what Diameter such Roots were?

The latter part of the 4th Experiment appearing so manifestly to disagree with some Experiments, I have made this Year, as well as formerly, in Roots and Branches of Trees; whereby I found, that not only Cold weather, but Cold Wind and Sun-setting stopped or abated the Motion of Sap in the Sycamore: Which puzzleth me, how to direct an Inquiry to find out the Cause of this singular Experiment, and of the Observations also in the 11th Experiment, which highly confirms this. The best directions I can at present devise, (untill the Experimenters shall please to give us an account of the Time, Season, and that not only by the Month, day, hour, but also by the wind, and the motions of the weather-glass, before, after, and at the instant of those Observations;) are the ensuing; which we shall conclude with some other inquiries.

1. What the difference of the Seasons of that Experiment was from the foregoing? 2. Whether the Heat were so great, when the Sycamores so sensibly abated, that it coagulated their Juice, and, by thickning it into Jelly and so into wood, ended the running? And therefore 3. Whether this Experiment of Cold, promoting, and of Heat, stopping the bleeding, were not in the later end of their running only, and not in the former? And if so, Whether 4. the rising of Sap be not rather to be attributed to the Degree of heat, than the Abatement of Heat? 5. Whether the reason, that the Birch increased, when the Sycamore abated, be not also to be imputed to this, that the Birch runs not ordinarily till March (unless in a forward season) and the Sycamore and lesser Maple in January; and so the season of the ones Sap, beginning sooner, doth also end sooner: And whether thereupon it be not observed, that the season of the Birches Jellying into wood will not commence till a greater heat, as that of May; whereas the Maple-Sap probably will condense to Jelly and wood in a lesser heat, as that of March going out, or April beginning? 6. Whether this be not also probably the reason of what is observed in the 12th Experiment in the same N. 48. viz. the sycamores running more on the North, and less on the South-side, contrary to my yesterdaies Observation (March 1. 1669,) the Southern branches yet dropping in the afternoon when others ceased? 7. Whether the Birch also in such seasons, after the Maple and Sycamore cease running, will not bleed more in colder weather, suppose in the middle or beginning of May, or later end of April, and so verifie my Experiment of the Sycamore running in hotter, and staying in colder seasons, or in the sign Pisces, the latter end of February, and the beginning of March; and on the contrary, running in colder and staying in hotter seasons, viz. of Aries or the latter end of March and the beginning of April: Or briefly, In what Signs, and what weather as to wet and dry chiefly, the Birch and Maple bleed in hot, and stay in cold weather, & vice versa? Which temper of weather I would have accurately observed by Weather-glasses and Barometers. 8. If this be found to verifie my Conjecture, then Whether by the running and staying of these Trees, and the first rising and ceasing of their Sap, may not probably (in some measure, by diligent Observation and comparing Ob-

ervations of time, season, weather, glasses, &c. be found the difference of Climate, Land, and Situation; as also of Years forwardly or late fruitful, or of years unfruitful? 9. Whether the Observations of *Quality* as well as *Quantity* of Sap by Distillations after fermentation, &c. may not also conduce to the Prognostique of the Fruitfulness or Barrenness of a year, especially in *Walnuts*, and such Fruit-Bearers as yield plenty of Sap, and by analogy and observation from them to others: As (e.g.) whether a fruitful or unfruitful year of Hazel or Filbert-nuts may not probably be discovered by their Scarlet-blossoms, not appearing this year till now? (*March 2.*) 10. Whether Ablaqueation (or digging about and baring the roots of Trees) will retard the rising of Sap in the Walnut &c. and what other effect it will have on fruit, &c? And whether such Baring of Roots of Pear, Plum and Cherry-trees (which are as much forwarder than Apples, as Maples are than Birch &c.) and generally of all forwarder Trees, should not be made in different seasons (accordingly) from Mulberries and such like? 11. Whether Amendment of ground, laid after the Sap ceaseth, be not fruitless, as to that year, or much less beneficial than what is layd before? 12. Whether the seasonableness of watering may not be found and promoted by a right Inquiry, and by a due satisfaction to these Queries? 13. Whether Ablaqueation, watering, Amendment, &c. according to these seasons, may not be so directed, as to increase Fruit, Wood, or both, or either at pleasure? 14. Whether Ablaqueation, which so alters the rising of Sap, that it curdles them, when it should run, doth not hurt? 15. Whether the same hath influx on the Leaves, Suckers and outward products of the Tree, or on the inward also, as fruit, or only increases their quantity, by accident hindring the growth and draught of other parts which did robb the fruit? 16. Whether the Cool seasons of the Night afford not some temperament in these cases, so that thereby, as tis in cool seasons, the Sap runs and Jellies by day, as it runs by night? 17. Whether in some warm days, in which the *Sycamore* runs not at Noon or in the heat of the day, it run in the Night, or the Cool of the day, and, on the contrary, the *Birch* run by day or about Noon. and cease at Night or Sun-set, in the same seasons? 18. The same Queries might also be prosecuted in the Hop, which runs after the extreame heat of the Summer, after the Hops are ripe and gathered, or any other Plant, that runs in Summer or Autumne, if there be any such.

So far the Inquisitive Doctor for this time: To which we cannot but subjoyn the Letter of that Worthy and Observing Gentleman, Mr. Villoughby, containing an Answer to such of the precedent remarks and Inquiries, as concerned him, and therefore were imparted to him. It runs thus.

Sir, 'tis no wonder, that Dr Tonges Experiments concerning the Bleeding of the *Sycamore* do not agree with ours, they being made in a different season; his, in *February*, and ours towards the end of *March*, viz. the Cold, which caused the Increase of the bleeding in the *Sycamore* and *Walnut*, hapned upon the 23. 24. 25. 26. *March*; and one *Sycamore*, which ceased to bleed from the 11th of the same Month, bled afresh copiously from wounds that had been made so long before: The Buds before the cold were just ready to open into Leaves, and the Sap had begun to coagulate above a fortnight before. This year, making incisions in the *Sycamore* and common Maple, in *January*, immediately upon the relenting of the first Frost, we found that they both bled, and faster, as the weather grew hotter; nor did the succeeding Cold promote, but rather hinder their bleeding. So that the Learned Doctor doth most ingeniously conjecture, that the Ascent of Sap in Trees depends upon a certain Degree of heat, sufficient to raise, but not to coagulate their respective Juices. In those Months, wherein the Heat ordinarily falls short of that Degree, an accidental heat or warmth of weather promotes the bleeding; but in those Months, wherein the ordinary temper of the Air exceeds that Degree, an extraordinary fit of colder weather makes them bleed again.

The Experiments concerning the Northern and Southern sides of *Sycamores* &c. made at the same time; and are well solved by the same Hypothesis.

In *Walnut*-trees, we never yet found, that Heat promoted their bleeding, but always Cold. From a wound, made in a *Walnut*-tree, in *January*, and the beginning of

of this pretent *March*, in mild weather, nothing issued; but the weather changing and growing colder, it bled plentifully: Which seems not well to consist with that Hypothesis, and must be better examin'd.

Last year, the 6th and 7th of *March* was made the Experiments of the Bleeding of Poles (held perpendicular) at both ends, in Willow, Birch, and Sycamore: which may so easily and certainly be found to succeed, in a great latitude both as to the bigness of the boughs and temper of the weather, in the best Bleeding season, that there needs no such exact niceness in the Observation of those particulars. The 11th of *March*, Roots of Birch, great and small, bled both ways; and about the same time, Sycamore roots also. Of all which I doubt not, but Dr *Tonge* is by this time fully satisfied by his own Experiments. The same Birch, which first began to bleed the 3d of *March* this Year, bled 3 weeks sooner last year.

Trial would be made, whether Cold will dissolve the Sap already coagulated: Else it will be hard, in the Doctors Hypothesis, to give an account of the Trees dropping a new in Cold weather.

It was last Autumne observ'd by our ingenious Friend Mr *Martin Lister*, that upon the first Frost, which hapn'd in *November*, a Sycamore bled copiously; so that the Sap cannot be said to rise in *January*, but immediately after the Fall of the leaf, in this Tree.

Our Experiments, which you have already printed, are most true, and according to the Doctors Hypothesis, will very well agree with his. His Deductions and Inquiries are very rational and well deserve to be made publick. Various interruptions have hindred us from the diligent prosecuting of these Experiments this *Spring*; which that I may more critically make hereafter, I must procure two Sealed Thermometers and two Barometers. I am &c. Dar. Middleton in Warwick-shire *March* 16⁶⁹.